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Vegetable decolorizing carbons and their use in the cane sugar industry

Frederick William Zerban

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PREFACE

This station has, during the past few months, received a great many requests for information on the preparation and uses of the active decolorizing carbons which have lately created such a stir in the sugar world. In order to satisfy this demand, it was decided to assemble in a short, non-technical bulletin all the important data existing on the subject, including the results of some laboratory and sugar house tests made at this station during the past grinding season. In publishing this information, we are well aware of the fact that our knowledge of these carbons and of their practical application is still very limited, and we hope that the present contribution, incomplete though it be, may help to clear up some questions about which there has been a difference of opinion.

The writer gratefully acknowledges the kind and efficient cooperation of Mr. W. G. Taggart and Mr. A. J. Keller, especially in the sugar house tests. Thanks are also due to Mr. A. G. Davis, who assisted in the analytical and other laboratory work.

Vegetable Decolorizing Carbons and Their Use in the Cane Sugar Industry.

By F. W. Zerban, Ph. D.

BRIEF HISTORICAL SKETCH.

Attempts at the utilization of the absorptive qualities of wood charcoal in the sugar industry date back about one hundred and twenty-five years. In 1785 Lowitz called attention to this useful property of charcoal, which had been long known before him and had been forgotten again. He subsequently made some tests on sugar syrups, but apparently without success. However, in 1794 an English refinery actually used charcoal for decolorizing raw sugars, with good results. Not many years later this same material was to play an important part in the history of the sugar industry, helping to place the young and struggling beet sugar industry on a firmer basis. It was with the aid of charcoal, in addition to other improvements, that Delessert made a practical success of the manufacture of sugar from beets at his Passy refinery, in 1808. This favorable outcome prompted Napoleon Bonaparte to cause the erection of additional factories, and thus led to the establishment of the beet sugar industry in France.[1]

But at just about that time—in 1812, the decolorizing effect of bone-black was discovered, and it was soon found that this form of carbon was superior in decolorizing power to ordinary wood charcoal. It quickly took the place of the latter, and for a number of decades following was in many places believed to be an absolute necessity for making good sugar, in both refineries and raw sugar factories. It is now no longer considered of such paramount importance, but is still being largely used by refiners.

Notwithstanding the great success of bone-black, wood charcoal was not entirely forgotten, and its good qualities as a filtering material were rediscovered several times during the past hundred years. In 1836 Boettcher recommended the use of brown coal or lignite, which is a natural carbonization product of vegetable matter, for refining sugar to be sent to the East Indian market, on account of the religious scruples of the Hindoos regarding sugar made with the aid of bone-black.[2] Around the middle of the century sugar charcoal, and, once again, brown coal were given favorable mention.[3]

About thirty years later the subject of vegetable carbons was revived anew and created a good deal of discussion at the time. There was a spirited controversy between Casamajor, chief chemist of Havemeyer & Elder, who was in favor of using finely ground crude sawdust as a filtering medium, and Remmers, of England, who, at first, recommended powdered wood charcoal, patented by himself, and afterwards a certain kind of specially pulverized lignite, patented by Kleeman.[4] Rather exhaustive tests of the last two processes were carried out in Demerara in 1886, and in Louisiana, at Magnolia, in 1886, and at Calumet in 1887; some experiments were also made about that time at the Louisiana Sugar Experiment Station.[5] Mr. W. J. Thompson, who reported on the Calumet experiments, expressed himself in favor of wood charcoal which gave a larger increase in purity, although the lignite exhibited a declorizing power about ten times as great. It is interesting to note that Remmers, in his British patent granted in 1881, describes the revivification of wood charcoal by boiling with alkali, a method which had been in use for several decades in regenerating bone-black.

After another thirty years' intermission the subject was once more taken up, as it had meanwhile been found that vegetable chars of high decolorizing power can be prepared by special methods. This fact in itself was not new, since almost one hundred years ago Bussy and other French chemists had devised methods for greatly increasing the decolorizing effect of chars of both animal and vegetable origin.[6] A series of patents for the manufacture of active vegetable carbons have been taken out since the early eighties, and their number has greatly increased during the past seven years.

Many vegetable decolorizing carbons are now on the market in this and other countries and are being used in various industries. They are sold under different trade names, like Eponit, Filtchar, Flaming, Flandrac, Littoral, Norit, etc.[27] It is difficult to ascertain how many of these have been tried in sugar factories, but as far as the writer is aware, the practical use of only a few of them has been discussed in the more widely read sugar journals. These are Eponit; Norit; the bagasse char advocated by Weinrich in 1891[7] and in a purified form by Clacher in 1914[8];

the widely discussed rice hull carbon, recently discovered in Louisiana[9]; and the char prepared from filterpress mud, according to the processes recommended by Karlik and Stanek in 1903[10], by Hazewinkel[11] in 1911, and lately by Sandmann.[12]

PREPARATION OF VEGETABLE DECOLORIZING CARBONS.

It has already been mentioned that almost one hundred years ago some French chemists found a way for increasing the decolorizing effect of chars, including those of vegetable origin. It consisted in mixing the raw material before carbonization with other substances, like chalk, flint, pumice stone, etc. These additions serve the same purpose as does the calcium phosphate of bones in the preparation of bone-black—that is, as a skeleton on which the carbon particles are deposited. A finer distribution of the carbon and a more porous structure are thus obtained. This is of importance, because the decolorizing power of carbons is evidently closely associated with their porosity, although other factors also seem to play a part. As it is not the purpose of this bulletin to discuss questions of solely scientific character, the readers specially interested in the theoretical side of this subject are referred to an article by Schneller, published in the Louisiana Planter for September 8, 1917, page 154.

It is now known that the increase in decolorizing power may be effected in several ways. It can be accomplished by simply heating the vegetable char, without any admixture, to high temperatures in the absence of air; or by first mixing the raw material or char with other "impregnating" substances and heating the mixture under conditions which prevent the oxidation of the resulting carbon. The impregnating substance is afterwards partly or wholly removed by treatment with proper solvents. Heating in a current of water vapor, or of certain gases or mixtures of gases, is also used for imparting high decolorizing power to vegetable chars.

Systematic investigations on several of the methods just mentioned have been in progress for some time at the Louisiana State University, and since last year also at the Louisiana Sugar Experiment Station. Coates, at the university, has found that

ordinary wood charcoal from sawdust, the decolorizing power of which is only very slight, can be converted into a carbon equal to Norit by prolonged heating to 1200° C. in a covered crucible. This corroborates the results obtained by Lotz with lignite, in 1911.[13]

At the experiment station tests on the preparation of carbons from sawdust by means of impregnating substances were begun last year by Schneller, and they are being continued. It was found, among other things, that a carbon of the same appearance and of properties similar to Norit and Eponit, the manufacture of which is kept secret, may be prepared by mixing sawdust with milk of lime, driving off most of the water, heating the mixture in a closed receptacle in a muffle or Fletcher furnace, treating the mass after cooling with hydrochloric acid, washing and drying. When two parts of lime are used to three parts of sawdust, a carbon of the same decolorizing power as Norit is obtained, while that made from equal parts of the ingredients results superior to Norit. These results were confirmed by investigations carried out independently in England.[14]

Other active carbons were made at the experiment station by using certain metallic chlorides as impregnating substances. In 1913 Zelniczek patented the use of zinc chloride for this purpose, and that of calcium and magnesium chloride was also proposed.[15] We have found that other chlorides will give carbons which are as good or better than those prepared with the chlorides just mentioned. Tin crystals (protochloride of tin) serve as well as zinc chloride, and anhydrous magnesium chloride produces a carbon fifteen times as active as Norit, while that made with ordinary magnesium chloride is a little inferior to Norit. We have also established certain relationships between the physical properties of the impregnating chlorides and the decolorizing effect of the carbons prepared with them. These investigations will be published in detail in a technical bulletin.

Vegetable carbons of high decolorizing power have further been obtained from raw materials which are already impregnated, either by nature, or incidentally by some manufacturing process.

It was shown at the experiment station that active carbons may be prepared from those plants or parts of plants which have a high percentage of infusible ash, consisting, for instance, principally of silica, or of lime salts.

The highly silicious parts of certain grasses, like rice hulls or leaves, barley awns, etc., yield very active carbons. Cane bagasse also has ash rich in silica. The decolorizing effect of the chars made by simple carbonization of these materials is only slight, and must first be developed by removing the silica from the char. This can be effected by boiling with caustic soda solution, preferably under pressure, or by fusing with carbonate of soda or caustic soda. In the case of rice hull char, boiling with a water solution containing 20% of caustic soda on the weight of the char, has been found to give good results. After removing the soda by washing with water and a little acid, a carbon is obtained which exhibits about one and one-half times the decolorizing effect of Norit. This carbon now contains only 9% of ash, as against 50% in the char, and, according to Schneller,[16] it is useless to remove more ash by employing higher concentrations of soda, because the decolorizing power of the carbon is not further increased thereby. The quantity of soda to be used in treating the other silicious materials mentioned above will depend on the percentage of silica contained in them. The silica may also be removed by treatment with hydrofluoric acid, but it is doubtful whether this method could successfully compete with the caustic soda treatment, since the latter furnishes silicate of soda as a by-product which ought to command a good market.

The impregnating substance of the carbon from filterpress mud, advocated by Sandmann, consists largely of phosphate of lime, because the inventor proposes to use lime and phosphoric acid for clarification. The mud is dried, charred, and the decolorizing power of the char is then developed by boiling it with just enough hydrochloric acid to cause a distinctly acid reaction. About one quart of the commercial acid is required to every five to seven pounds of char. The carbon is then washed and may be dried if desired.

PROPERTIES OF VEGETABLE DECOLORIZING CARBONS AND METHODS OF EMPLOYING THEM.

The vegetable decolorizing carbons are usually sold in the form of a fine, intensely black powder. They are light in weight, their apparent density depending largely on their degree of fineness, and to some extent on the ash found in them. Their composition varies somewhat, but they are generally characterized by a high carbon and low ash percentage; they differ in this respect from ordinary bone-black, which usually has only about 10% of carbon and a very high ash content. Eponit, when perfectly dry, contains over 90% of carbon, and less than 4% of ash, and Norit has a similar composition. Eponit, according to Strohmer, has small quantities of oxygen, hydrogen, and nitrogen[17]; Coates, and also Sandmann, have found hydrogen in other vegetable carbons. Norit, however, is claimed by Wijnberg to be absolutely free of these constituents and to consist entirely of amorphous carbon with a small quantity of ash.[18]

The property which makes the vegetable decolorizing carbons especially useful is their power to remove coloring matter and certain other substances from solutions. When used on crude sugar products, they show their effect in three different ways, which are, however, to some extent interdependent. They produce a permanent and very pronounced decolorizing effect, increase the purity, and largely improve the filtrability of sugar products. Only quite small quantities of carbon are usually necessary to produce a considerable effect. The carbon is simply mixed with the solution, which is then heated for a short time and filtered. The effect is usually greater in dilute solutions than in concentrated ones. The carbons also act more efficiently when the medium is slightly acid to litmus than when it is neutral or even alkaline.

The decolorizing power of Eponit and Norit is from ten to over thirty times as great as that of ordinary bone-black, depending on the composition of the product used and the condition of the experiment. Rice hull carbon and Sandmann's carbon from filterpress mud, when properly prepared, are equal or superior

to Norit. We have no figures on bagasse carbon, but its decolorizing effect is probably rather low, because dry bagasse contains only about 5% of ash and consequently still less silica.

Weinrich has lately stated that the decolorizing power of chars is determined by their volume rather than by their weight, and that equal volumes of various carbons have the same decolorizing power.[19] The results obtained at the experiment station do not bear out this contention.

The removal of other organic and mineral impurities, besides color, has lately also been questioned by Weinrich, on the basis of experiments made with the vegetable chars known about thirty years ago.[19] Weinrich claims that vegetable carbons do not remove organic and mineral impurities, but only color, while bone-black acts on all of them. This criticism has very recently been refuted by Sauer,[20] and we have also found that under the conditions used by us, Norit and rice hull carbon do remove nitrogenous substances, gums, and ash constituents, even though in small quantities. W. J. Thompson, whose work was mentioned on page 6, likewise found an increase in purity of 1.5 to 4.3 points from the use of ordinary wood charcoal on cane juice.

Some of the substances taken up by the carbon are not as firmly held as others, and are therefore more easily removed by washing. Sugar itself does not seem to be absorbed at all, and can therefore be readily recovered. This whole subject will be discussed more fully on pages 27-31.

The question as to what particular constituent of the carbons is the real decolorizing and purifying agent, has been extensively studied, as has also the other question, whether this removal of impurities is a physical or chemical process, or both, and exactly how it is brought about. Some of these problems are being studied at the university and at the experiment station, but we shall not enter into this phase of the discussion here, especially as this subject has been very ably treated by Schneller in the article already referred to.

All the advantages which we have mentioned so far would not be sufficient reason for making practical sugar house tests with these carbons, unless they were exceedingly cheap or unless they could be used repeatedly. The carbon, by taking up im-

purities, naturally becomes less effective after each operation. Since the carbons at present on the market are anything but cheap, the question of their repeated use becomes very important. It has been found that when relatively large quantities of carbon are employed in proportion to the impurities to be removed, the carbon can be used several times, if it is simply washed with water after each operation. But when a certain amount of foreign matter has accumulated in the carbon and its efficiency is decreased thereby, it becomes necessary to remove the impurities by some special treatment. This can be accomplished by several methods which have all been used for a long time in the revivification of bone-black. The simplest, but least effective, way consists in boiling with dilute hydrochloric acid and washing with water, which process removes some of the foreign substances, especially mineral matter. The carbon may now be used again a few times, but after this a more thorough method must be employed. For this purpose alkaline substances, like ammonia, sodium carbonate, and particularly caustic soda have been recommended. About 5% to 10% of caustic soda, calculated on the weight of the carbon, are added to the latter; the whole is mixed with water to form a rather thick paste, which is then boiled for half an hour or longer. The soda takes out a large portion of the impurities, and the solution assumes a dark brown color. The carbon is now filtered through a press, washed first with hot water, then with a little very dilute hydrochloric acid to remove the last traces of soda, and finally again with water. This method is quite effective on carbons that have not been put to very hard use, but it is rather expensive. The caustic soda method, although about a century old, has recently been patented again by Wijnberg for use with Norit and similar decolorizing materials of high carbon content.[18] The most thorough way of revivifying decolorizing carbons consists in reburning them in the absence of air, which converts all organic impurities into carbon. Then it is only necessary to remove the mineral impurities with hydrochloric acid, and to wash with water. We have found that this method completely restores the decolorizing power of carbon

which was saturated with foreign matter. The inventor of Norit has patented a special kiln for the reburning of vegetable carbons.[21]

In factory practice, there is, of course, always a small loss of carbon, mostly mechanical, the extent of which will depend on the care with which the various operations are carried out. This loss has to be replaced with fresh carbon.

The revivification of carbon, which is such an important item in factory practice, is entirely avoided by the process recently proposed by Sandmann. When using any of the carbons which have to be revivified for reasons of economy, they must be added to the clarified juice and not to the raw juice. Otherwise the carbon would be contaminated with such quantities of precipitate that its revivification would become most difficult. Sandmann's carbon, however, is added directly to the raw juice, which is then, without previous filtration, acidified slightly with phosphoric acid, and at once again nearly neutralized with milk of lime. According to the inventor, a much better clarification is obtained by this method than by using the different ingredients separately and filtering after each operation. This not only saves one, or even two, filtrations, but also entirely prevents the contamination of the filtered liquor with fine carbon particles and produces a filtrate of extreme brilliancy. The mud obtained in the clarification process is again ignited and treated with muriatic acid, exactly as in the beginning. Thus a new batch of carbon is produced in every operation. The solution obtained in treating the char with muriatic acid can be neutralized with lime which will precipitate calcium phosphate. This can either be used as a fertilizer or it can be reconverted into phosphoric acid which again enters the process. In the latter case only lime, muriatic acid, and a small quantity of phosphoric acid to replace unavoidable losses would have to be bought. Every factory would be able to make its own carbon, and produce even more than is needed.

This process would, of course, render the application of manufactured carbons absolutely useless. It remains to be seen, however, whether the burning of the necessary quantity of mud for preparing the required carbon can be done economically.

PREVIOUS FACTORY TESTS.

Several ways have been suggested for the utilization of vegetable decolorizing carbons in the cane sugar industry. They might be used on juices, factory syrups, light colored raws without previous affining, and on washed tropical sugars. In the last named case the washings could also be treated with carbon, and worked into high grade consumption sugar. The same thing could be done with seconds.

A perusal of the current sugar literature would indicate that the only factory tests that have so far been reported on were made with Norit and with rice hull carbon.

The first British patent for the use of Norit in the sugar industry was granted to Wijnberg and Sauer in the year 1911.[22] The original mode of working was considerably modified in later patents, especially as regards the revivification of the Norit. Many articles on the working of this process have appeared,[23] so that it will suffice here to state only the salient points as set forth by the inventors.[24] Norit may be used for refining raws, or for making plantation whites directly from the cane. The quantity of Norit used varies from 3% on washed raw sugars to 5% to 6%, calculated on the sugar, in raw cane products. The carbon is added to the clarified juice or melted sugar, as the case may be, the mixture heated for a short time, passed first through filterpresses and then through a Danek or similar gravity filter, no other kind of filter being required in the whole operation through to the finished product. Filtration is very rapid, so that only a few presses are needed. The same Norit can be used over several times, and must then be revivified by the methods described in the foregoing chapter. The entire cycle may be repeated a number of times, and the quantity of Norit used over and over again, at least one hundred times. Only the small mechanical losses have to be replaced by adding the necessary amount of fresh Norit. The inventors claim that the cost of refining raw sugar is only 36 cents per ton in a 100-ton refinery, owing to smaller cost of machinery, operation and labor, combined with better yields and saving of time.

Experimental runs with Norit[23] were made at a cane sugar factory in Natal in 1913, and on a much larger scale again during the following year, using the carbon on slightly acid juice made by the sulphitation process. Norit was also tried at a Scotch refinery in 1913, and again in 1914, when the same quantity of the carbon was used thirty times in succession. According to Wijnberg, the process was introduced three years ago at one of the largest refineries in Canada. It appears to have been tested in Hawaii and was actually used last year for refining raws in two beet sugar factories in Holland. Experiments in Java cane factories were started in the year 1914, at the Krian factory. Here the Norit was added to the clarified, neutral sulphitation juice, together with some acid phosphate, to make the reaction distinctly acid. The published results on all these trials were very favorable. It has recently been stated[20] that the Norit process is now being used in about forty sugar factories and refineries.

The Krian factory installed the complete Norit process for the 1915-16 campaign, but several difficulties were encountered at the beginning. These were, however, remedied during the grinding season, and it was expected to take up the full operation of the process in 1916-17, in order to arrive at definite conclusions. So far, the writer has not heard anything about the results obtained during that campaign. Jentink, who saw the process worked at Krian in 1915-16, expresses the following opinion:[25] "In Java this process has not yet been adapted for work on a large scale, so that it would be useless to make comparisons with other purification methods. However, the factory tests that have been made gave very good results; the sugar which was prepared by this process may be considered superior in quality to the sugars produced so far in Java." Further on he states that the price of Norit and the cost of regenerating it will be deciding factors in judging the value of the process.

It may be said that the Louisiana Sugar Experiment Station has arrived at about the same conclusions as those expressed by

Jentink. Several runs were made last year at the sugar house of the station, under the auspices of Mr. C. D. Kemper, by a representative of the Norit White Sugar Company. Both washed and unwashed Louisiana 96 test sugar were treated with 5% Norit, after acidifying with a little phosphoric acid, and all of them boiled to grain. The washings were also treated, and grained with the molasses made before. The claims of the inventors that much time can be saved in filtration and that a high grade white sugar can be made by the process were substantiated by the results. The carbon was revivified after each operation by boiling with caustic soda. No conclusions can, of course, be drawn from these tests concerning the financial side of the question.

A test similar to the ones just mentioned was made at the sugar house of the station in July last year with rice hull carbon, at the request of some planters and under the auspices of Messrs. Blardone, Fornaris and Laroussini, of New Orleans, who also furnished the char used in the experiment. Unwashed Louisiana 96 test sugar was refined with 5.5% rice hull carbon, and the results were the same as those obtained before with Norit. Nearly a ton of sugar melted to 60 Brix was passed through 120 square feet of filterpress area in 27 minutes.[26]

LABORATORY AND SUGAR HOUSE TESTS MADE AT THE STATION DURING THE GRINDING SEASON OF 1917-18.

During the past grinding season the experiment station took up a more comprehensive study of the effect of Norit and rice hull carbon on cane juice and syrup, and made several sugar house runs in which rice hull carbon was used in connection with different methods of clarification.

Some laboratory tests were first made to study the decolorizing effect of varying percentages of Norit on juices clarified by different methods. In one series the juice of Louisiana purple cane, expressed in a laboratory mill, was used, and in each clarification experiment quantities of 0.0, 0.25, 0.5, 1, 1.5, 2 and

2.5% of Norit, on the weight of the juice, were added. In the second series we used juice from the seedling L-511, and reduced the percentages of Norit to 0.5, 1, and 1.5.

A list of the tests follows:

No. 1—Norit added to raw juice, boiled, filtered.

No. 2—Juice limed to 0.5 cc acidity, Norit added, boiled, filtered.

No. 3—Juice limed to 0.5 cc acidity, boiled, filtered; Norit added, boiled, filtered.

No. 4—Juice limed to neutrality, phosphoric acid added to 1 cc acidity, then Norit; boiled, filtered.

No. 5—Juice limed to neutrality, phosphoric acid added to 1 cc acidity, boiled, filtered; Norit added, boiled, filtered.

No. 6—Juice limed to neutrality, boiled, filtered; phosphoric acid added to 1 cc acidity, then Norit, boiled, filtered.

No. 7—Juice sulphured to 5 cc acidity, limed back to 0.5 cc acidity, Norit added, boiled, filtered.

No. 8—Juice sulphured to 5 cc acidity, limed back to 1.5 cc acidity; Norit added, boiled, filtered.

No. 9—Juice sulphured to 5 cc acidity, limed back to 0.5 cc acidity, phosphoric acid added to 1 cc acidity, then Norit, boiled, filtered.

No. 10—Juice sulphured to 5 cc acidity, limed back to 0.5 cc acidity, boiled, filtered; phosphoric acid added to 1 cc acidity, then Norit, boiled, filtered. (Used only on Louisiana Purple.)

No. 11—Juice sulphured to 5 cc acidity, limed back to 0.5 cc acidity, phosphoric acid added to 1 cc acidity, boiled, filtered; Norit added, boiled, filtered.

No. 12—Juice sulphured to 5 cc acidity, limed back to neutrality, resulphured to 1 cc acidity, Norit added, boiled, filtered. (Used only on L-511.)

The list shows that the following clarifying methods were used: No clarification in test 1; lime alone in tests 2 and 3; lime and phosphoric acid in tests 4 to 6; sulphur and lime in tests 7, 8, and 12; sulphur, lime and phosphoric acid in tests 9 to 11.

In tests 3, 5, 6, 8, 10, and 11 the juices were first treated with the clarifying agents, heated, and filtered before adding the Norit; in the remaining tests—1, 2, 4, 7, 9, and 12—the Norit was added before heating and filtering, together with the other clarifying agents employed.

It would have been desirable to determine the exact color in all of the 88 juices. But it was found that the tints obtained in one clarifying process were often so different from those produced in others that the only thing we could do (without having recourse to an exact tintometer) was to arrange all of the samples in regular order, according to depth of color only, and to pay no attention to the exact shade. Observations were made by looking horizontally through the column of liquid contained in cylinders of two inches diameter. The whole series was then divided into nine groups of increasing depth of color, as follows: 0, water white; 1, almost water white; 2, barely colored; 3, very light straw color; 4, light straw color; 5, straw color; 6, light amber; 7, dark amber; 8, brown. In classes 3 to 8 red or greenish shades were observed, depending on the method of clarification.

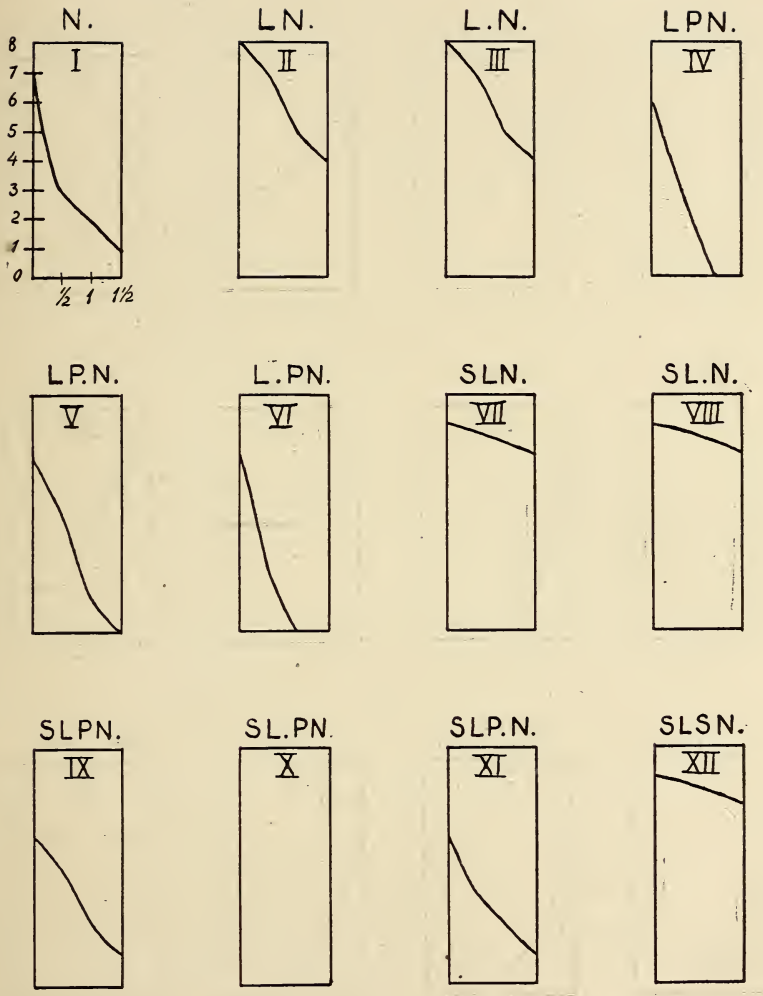
The effect of the various methods of clarification and of the Norit on the color of the juices is clearly shown in the diagrams on pages 19-20. The percentages of Norit are plotted horizontally, and the colors vertically. N signifies Norit, L lime, P phosphoric acid, S sulphurous acid, and a dot denotes boiling and filtering.

Where no Norit at all was used, the lightest colored juices were obtained by clarification with sulphur, lime, and phosphoric acid (9, 10, and 11); then follow lime and phosphoric acid (4, 5, and 6); sulphurous acid and lime (7 and 8); lime alone (2 and 3).

Where Norit was used, the highest increase in decolorization was obtained on juices clarified with lime and phosphoric acid; as little as ½% produced a strong decolorization, and with 1% the juices became practically water white. A further increase in Norit had little, if any, effect.

The carbon did not give as good results on juices clarified with sulphurous acid and lime; in the case of purple cane ½% of Norit produced only a slight effect, and it took at least 1% to reduce

L 511.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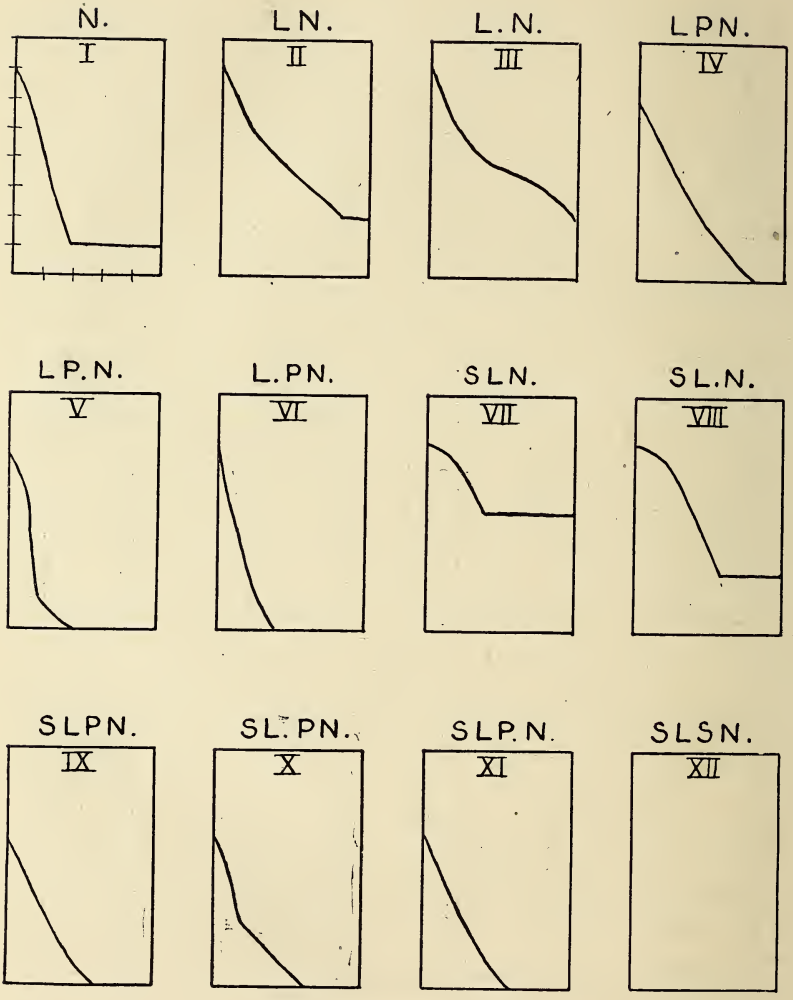
XII

LOUISIANA PURPLE.



the color to "light straw." A comparison of juices 7 and 8 shows that a better effect is produced on the more acid juice. In the case of L-511 cane the effect of Norit was even less than with purple cane; nor did a further acidification with sulphurous acid have any effect.

In the clarification with sulphurous acid, lime, and phosphoric acid, the Norit effected a better decolorization than where only sulphurous acid and lime were used, but not as good as where only lime and phosphoric acid were employed. It took about ½% more Norit to get the same color as brought about with lime and phosphoric acid alone, although the final acidity of the juices was the same. It is impossible to explain this behavior with our present knowledge of the coloring matters of the cane.

Where only lime was used for clarification it took considerably more Norit to cause the same decolorization as obtained in the other clarification methods. This stands to reason, because the clarified juices themselves had much more coloring matter left.

The experiments teach that the least colored juices are obtained and the greatest saving of Norit can be effected by clarifying with lime and phosphoric acid. There are, however, two difficulties in the way. Phosphoric acid is a rather expensive article, as compared to sulphur, and, besides, juices clarified with lime and phosphoric acid do not settle near as well as those clarified with sulphurous acid and lime. The carbon has to take up all the mechanical impurities in the clarified juice, unless it is previously filtered, and the carbon would, therefore, have to be revivified oftener. This trouble may readily be overcome by Sandmann's process, already repeatedly mentioned. But where the carbon has to be revivified it would, perhaps, be advisable to clarify with sulphurous acid and lime, because here the clarified juice does not carry so much precipitate. A small quantity of phosphoric acid added along with the Norit to the clarified juice will cause a great improvement in color. The danger of inversion due to an acidity of 1 to 1.5 cc is only slight and is largely counterbalanced by the improvement in the color of the product. It can, moreover, be completely avoided by neutralizing the decolorized juice with lime and filtering again. The color is not affected by this after-treatment.

After the tests just described the effect of carbon on the composition of the juice was taken up in the laboratory. The different methods of clarification were again used, as above: lime alone, lime and phosphoric acid, sulphurous acid and lime, and also carbonitation. Quantities of ½% and 1% of carbon were tried. These experiments were made with rice hull carbon instead of Norit, because they were to guide us in the sugar house experiments contemplated by us, in which we had decided to use rice carbon. Where ½% carbon was added, we did not find any rise in purity in any of the juices clarified by different methods. The figures for total nitrogen and ash did not show any marked change either, nor were the gums decreased to any extent, except where lime and phosphoric acid were used in clarification. There was a fall noted in albuminoid nitrogen, but as the total nitrogen did not change materially, this might be attributed to the splitting up of albuminoids through the repeated boiling. In those tests where 1% of carbon was employed, there was an average increase in purity of about ½ point, rising to 0.9 where lime and phosphoric acid were used for clarification. We observed a uniform decrease in the total nitrogen, averaging 11.9% of the total; also a uniform and marked decrease in the gums, averaging 29.8%, and being highest in the lime-phosphoric acid clarification. The average decrease in the ash was only 5%, and in the sulphitation juice there was even an apparent slight rise. We also found again a marked decrease in the albuminoid nitrogen, as in the first set.

The analyses are not given in full, because they agreed in a general way with those obtained later on sugar house products, which are more complete.

On the basis of the data obtained in the laboratory, Mr. Taggart and the writer planned five factory experiments. This was all we could do with the small amount of cane remaining when the tests were begun. They were made with the same rice hull carbon employed in the sugar house tests last July. It had been revivified with caustic soda and was not quite as effective as fresh material.

In each of these tests a quantity of raw juice was divided into two equal parts. One half of it was run into one clarifier, and the

second half into another. The two juices were in each test clarified in exactly the same way. The clarified juice from the first clarifier was then sent directly to the effects, while the other was treated with carbon, filtered through the filterpress, and then boiled to syrup, separately from the other. Each syrup was afterwards boiled to grain separately in our small pan, and purged in the centrifugal. One centrifugal charge was in each case dried without washing, while another was washed with a measured quantity of water, which was always the same for the sugar made with carbon and that made without it. In this way we hoped to obtain strictly comparable results. However, we were disappointed in this, owing to the fact that it is well-nigh impossible to boil two strikes exactly alike, especially when working with very green cane, as was the case this year, and with a small pan delivering only a hundred pounds of sugar and difficult to manage. It thus happened that in some cases we obtained a darker sugar from a lighter syrup, on account of the difficulty in purging. The molasses, however, again exhibited the lighter color corresponding to that of the syrup. It was, therefore, necessary to base our conclusions entirely on the composition and properties of the juices, syrups, and molasses. At any rate, these small scale experiments could not be expected to show more than the way by which the best results could be obtained, as far as quality is concerned, while investigations on the economic side of the problem must needs be carried out on a larger scale and over a much longer period.

The different juices, from mixed varieties, were treated as follows:

Test No. 1—Raw juice sulphured to 5.5 cc acidity, and limed back to 1.5 cc acidity. Bright juice obtained which settled well. Only scums and settlings run through the press. One half of the clarified juice brought to a boil with 1% of its weight of rice hull carbon, and passed through the filterpress.

Test No. 2—The clarification was carried out exactly like in the first experiment, with the same results, but the amount of carbon was reduced to ½%.

Test No. 3—Phosphoric acid added to the raw juice until an acidity of 3.5 cc was reached, then limed back to 1.5 cc acidity.

The clarification was poor and we found it necessary to send the entire juice through the filterpress. ½% carbon was used in this test.

Test No. 4—As we had obtained very light colored juices with the use of phosphoric acid, but at considerable expense for the acid, we decided to run another test with lime alone for clarification, and to add a small amount of phosphoric acid, ½ pound per ton of cane, at the same time when the carbon was introduced. The clarification with lime alone was poor, and all of the juice had to be filtered through the press. ½% of carbon was employed in this experiment.

Test No. 5—In this last experiment the carbon was used on the syrup instead of the juice. The raw juice was sulphured to 5.2 cc acidity, and then limed back to 0.3 cc acidity. The clarification was good, as is usually the case with carefully conducted sulphitation. All of the clarified juice was first boiled to syrup, one-half of which was then treated with two ounces of phosphoric acid per 1000 pounds of syrup, and with 5% of carbon, calculated on the weight of the sugar contained in the syrup.

All of the juices, syrups and molasses obtained in these five experiments were carefully analyzed. Measurements of the color and viscosity were made, and the speed of filtration observed, but not actually measured. We determined sucrose, reducing sugars, free acid, total nitrogen, ash, and gums. A detailed account of the reliability of the figures obtained is given under the respective headings on the following pages. The results of the analyses themselves are found in tabular form on pages 33-37. In order to make the figures comparable, the various non-sugars are, in the case of juices and syrups, expressed in per cent of total solids in the untreated products. In the molasses analyses this procedure was not possible, because unequal amounts of sugar were removed from the massecuites. We therefore based the figures in this case on equal amounts of total non-sugars (total solids less sum of sucrose and reducing sugars). Even these results are quite uncertain, on account of chemical changes taking place during the boiling, which are not under control, owing to unavoidable differences in temperature and time of

boiling. For these reasons we shall in the discussion to follow consider only the averages obtained in the molasses analyses.

Color.—The clarified juice in test 1 (sulphitation with 1.5 cc final acidity) after treatment with 1% carbon showed only 17% of the coloring matter found in the untreated part. In the syrup the ratio had risen to 24%, and in the molasses to 42%. This shows that during the concentration of the liquor a large quantity of additional coloring matter is formed, which causes a rise in the proportion between the color of the treated and that of the untreated products with increasing concentration.

In test 2, where the same clarification was used as in test 1, the carbon was reduced from 1% to ½%. This reduction had a marked effect on the color of the products. The color ratio between treated and untreated products was found to be 37% in the juice, 42% in the syrup, and 51% in the molasses.

By far the lightest colored products were obtained in test 3. The juice made by clarification with phosphoric acid and lime was in itself very much lighter than that prepared by any other method of clarification. The carbon, used at the rate of only ½%, removed 70% of the small amount of color in the clarified juice, leaving only 30% in the treated part. In the syrups the ratio of the color of the treated to the untreated product rose to 35%, and in the molasses to 56%.

In test 4 only lime was used in clarification, and the color of the clarified juice was therefore rather dark. When the carbon was added, to the amount of ½%, we at the same time acidified the treated half of the juice with phosphoric acid. Since this acid itself has a pronounced decolorizing effect, the reduction in the color due to the whole treatment amounted to as much as 84%, and the color remaining was only 16%. But this advantage was quickly lost upon concentration. In the syrup the ratio was found to be 44%, and 52% in the molasses. This result may possibly be explained by the fact that in the syrups the difference in acidity was not nearly as great as in the juices.

In test 5, where the carbon was used on the syrup instead of the juice, the treated syrup showed 40% of the color of the untreated, and in the molasses the figure rose even to 60%. The

ratio found in the syrups is about the same as that found where a corresponding quantity of carbon was used under similar conditions on the juice, while in the molasses it is considerably higher. The results show that the color formed during boiling is evidently not so easily removed, at least not at the natural consistenecy of syrup. These observations agree with those made by Thompson with lignite. When this material was added to the juice, it removed about one and a half to twice as much coloring matter as when used on the syrup.

Viscosity.—Contrary to our expectations, we could not find a measurable difference in the viscosity of the treated and untreated juices and syrups in any of the tests. In these investigations it was, of course, necessary to bring the untreated and treated products to the same density, as they would otherwise not have been comparable at all. But the difficulty which one encounters here, in spite of this precaution, is due to a fact established by Prinsen Geerligs in his classical researches on molasses formation. He found that the viscosity of sugar products of similar composition depends more on their absolute density than on their analysis. This in itself would explain the results obtained by us—namely, that products of the same density, but with small variations of impurities as found by analysis, showed no measurable difference in their viscosity. No viscosity determinations were made on the molasses, because here the question becomes more complicated on account of fine grain contained in them, and it would not be permissible to dissolve it with water, as was shown by Prinsen Geerligs.

It is interesting to note in this connection that both Mr. Taggart and Mr. Keller, who handled the strike pan in these tests, expressed the opinion that the treated syrups seemed to boil more freely than those which had not been treated with carbon. This would point to a decrease in the viscosity, which phenomenon, if actually present, could not be detected by the ordinary methods.

Speed of Filtration.—A great difference between the treated and the untreated products became at once apparent when we investigated the facility with which the different products could

be filtered through filter paper. The treated products invariably filtered much more rapidly than the untreated ones. This is most probably due to the fact that the untreated products contain impurities in the colloidal state of aggregation; they are retained on the filter and soon clog it. In the treated products, on the other hand, these impurities are coagulated by the carbon, and the liquid therefore passes through freely. In the sugar house it was always noted that the treated products filtered much more rapidly. This was especially marked in tests 1 to 3.

It has already been mentioned that the very fine carbon particles have a tendency to run through the filter cloths at the beginning of the operation, especially in the case of sulphitation juices. This difficulty can be obviated by running the liquors back through the press again, until they filter clear. At the Krian factory in Java the same trouble was remedied by adding milk of lime to the treated juice. The precipitate formed by the lime envelops the carbon particles, and upon filtration through Danek filters an absolutely clear, bright juice is obtained, without the color being affected in the least.

Purity.—The purity of the juices was determined, as usual, by single polarization and by spindling. It was later found that during the past grinding season this "apparent" purity was very much lower than the "true" purity. The same observation was made all over the state. This explains the great difference between the purities of juices and syrups. In the latter we determined the sucrose by double polarization, and the total solids by the refractometer. In the molasses double polarization and drying were employed. While for this reason the purities of the juice, and of the syrup and molasses obtained from the same juice, are not on the same basis, those for the treated and untreated products in each stage of the manufacture, except molasses, are strictly comparable.

In test 1, where 1% carbon was used on sulphitation juice, the rise in purity in the juice amounted to 1.1 points. ½% carbon used under the same conditions (test 2) caused an increase in purity of 0.6. Where phosphoric acid was employed instead of sulphurous, and ½% of carbon, (tests 3 and 4) the increase was 0.6 and 07.

In the syrups the differences in purity were generally larger than in the juices. In test 1 the rise amounted to 1.3 points, in test 2 to 1.2, in test 3 to 1.9, in test 5 to 1.6, but in test 4 it was only 0.3 points. This last result is explained by the fact that in this experiment more sucrose was inverted, during the boiling to syrup, in the more acid, treated juice, than in the untreated. The surprisingly large increase in purity in test 3 is similarly due to a smaller difference in the glucose ratios of untreated and treated syrups than was found in the corresponding juices.

The purity of the molasses is of no value in judging the effect of the carbon, because here the amount of sugar removed by crystallization plays the most important part.

There is no doubt but that the carbon treatment causes uniformly an improvement in the purity, the extent of which depends on the method of clarification and the amount of carbon employed.

Glucose Ratio.—In test 1 the carbon treatment did not bring about a material change in the glucose ratio, either in the juice or syrup. The short boiling of the juice, when the carbon is added, evidently does not cause any inversion, even at the acidity of 1.5 cc. There was, however, an increase in the glucose ratio from juice to syrup in both treated and untreated products. The high acidity thus showed its influence upon concentration of the liquors.

In test 2 there was also no change in the glucose ratio of the juices. The syrup from the untreated juice had a slightly larger ratio than the other, evidently owing to the fact that it had been boiled to a higher density. There was again a marked increase in the ratio from juice to syrup in both treated and untreated products.

In test 3, where phosphoric acid was used instead of sulphurous, the boiling of the juice with carbon apparently caused quite a little inversion. The writer is, however, inclined to the belief that this was due to incipient fermentation rather than to the acidity, as this juice had to be kept longer than the untreated part. The difference in the glucose ratio of the syrups was not as great as in the corresponding juices. For this reason the

difference in the purity of the two syrups was larger than one would have expected. Again the glucose ratio in both syrups was higher than in the corresponding juices.

In test 4, where only the carbon treated portion of the juice was acidified with phosphoric acid, there was, nevertheless, practically no inversion due to the boiling. But the higher acidity of the treated portion exerted its influence during concentration to syrup. The glucose ratio of the treated part increased 3.5 points, while that of the untreated rose only 2.1 points. For this reason the purity of the treated syrup was only 0.3 higher than that of the untreated.

In test 5, where the carbon was used on the syrup, together with a little acid, the glucose ratio of the treated syrup was actually a little lower than in the untreated.

We may conclude from these results that the carbon treatment in itself does not cause any inversion, and that any inversion which does take place upon concentration is caused by high acidity, which, however, can be avoided, as was shown in the Krian experiments, by first neutralizing the carbon treated juice with lime.

The glucose ratios in the molasses need not be considered, because they are more influenced by the acidity and by the time and temperature of the boiling than by the carbon treatment of the juice.

Free Acids.—The quantity of these is evidently not changed to any extent by the treatment with carbon. The largest change was 4.5% of the total, which is well within the limits of error. In tests 4 and 5 the acidity of the treated juices and syrups was, of course, higher than in the untreated, because in these experiments an additional quantity of acid was added along with the carbon. In the molasses the acidity was not determined, owing to the lack of reliable methods.

Total Nitrogen.—This constituent can probably be determined more accurately than any of the others. We found a small reduction of total nitrogen in all of the tests, in both juices and syrups. It averaged 8.3% of the total in juice and syrup of test 1, 8.2% in test 2, 4% in test 3, 4.9% in test 4, and 14.2% in

test 5. In this particular case the carbon seemed to be more effective when used on the syrup instead of the juice.

The average total nitrogen content of the molasses from treated products was 3.9% lower than in that from untreated.

Ash.—Methods for the determination of ash are not sufficiently accurate to ascertain very slight changes, and the results are therefore not as uniform here as in the case of nitrogen. In test 1 there was a slight apparent increase, well within the limits of error. In test 2 the treated juice showed a small decrease, which was just about counterbalanced by a small increase in the syrup. In test 3, however, we found a uniform and relatively large decrease in the ash. Test 4 showed about the same relations as test 2, but in test 5 we again find a more pronounced decrease. The results on the juices are more reliable, because the total quantity of ash in the syrups is influenced by the amount of incrustation, and is therefore affected by the density to which the syrup has been boiled, as well as by other factors like acidity, time and temperature of boiling. The treated juices show a decrease in three cases out of four, and the average reduction, counting all four, is 4.8% of the total. In test 5, where the syrup was treated directly, there was also a decided reduction in the ash. The average decrease in the syrups and in the molasses was only very slight.

It would appear that the carbon causes indeed a small reduction in the ash. The actual absorption of ash by the carbon is probably somewhat larger than that found in the filtered and washed products, because mineral substances absorbed by such purifying agents as carbon are usually more readily dissolved again by washing than organic constituents.

Gums.—This term comprises a number of different constituents of cane products, about the chemical nature of which we are still quite uncertain. It usually denotes those organic, nitrogen free substances which are precipitated by strong, slightly acidified alcohol. In analytical practice the last named reagent is used for precipitation, both ash and nitrogen are determined in the precipitate, and the necessary corrections applied. The determination of gums thus depends on three analytical oper-

ations, and the accuracy of the final figure is therefore of necessity much slighter than in the case of other constituents. We have to bear all this in mind in judging the effect of the carbon treatment on the juice. In the case of the syrups the chances of error are still greater, and even more so in the molasses, because gum-like substances are readily formed during the boiling by decomposition and interaction of others, and their quantity will depend on the time and temperature of the boiling and other factors. In the syrup analyses the alcohol was acidified more strongly than in the juice tests, and the absolute figures obtained are therefore smaller. For the reasons just given we have to be guided mainly by the analyses of the juices, and to consider also that the limit of error is rather large. The actual results in the juices were as follows: 14.9% decrease in test 1, 6.3% increase in test 2, 22.1% decrease in test 3, and 39.6% decrease in test 4. In test 5, where the carbon was used on the syrup, we find an apparent increase of 5.9%. Making allowance for a rather large possible error in this last case, this would mean that any actual reduction by the carbon treatment of the syrup must have been slight. In the juices, however, we find a decrease in three cases out of four, the average of all four tests being 17.6%. It is certain that at least part of the large reduction observed in test 4 is due to the high acidity of the treated juice. But even if the reduction here had not been more than in test 3, the average decrease would still amount to 13.2% of the total. The writer feels therefore justified in concluding that the carbon really caused a reduction in the gums. This is further strengthened by the fact that in the syrups the average reduction was 13.3%, and in the molasses 19.3%.

It is probable that the difference in the various constituents would have been more pronounced, if larger quantities of carbon than ½% and 1% had been tried. Further experiments will be made on this question, but in the tests described here it was our aim to determine what happens under practical working conditions.

The fact established by these tests—that the purity of the products is improved, that certain impurities are actually removed by the carbon, and that the decolorizing effect is consid-

erable and permanent—permits the conclusion that a larger amount of high grade sugar would be obtained by the use of decolorizing carbons than without them, or, in other words, that more molasses could be boiled back without impairing the color and quality of the product. There is no doubt but that for this reason the process merits a further investigation on a large enough scale and over a sufficiently long period to determine the economic aspect of the question. With the data we have at hand, it is impossible to decide whether it would be better to use the carbon directly on juices and syrups in the raw sugar factory, or to make raw sugar first and then refine it by means of carbon. In the latter case most of the coloring matter would go into the molasses, and the carbon would have to remove only the small quantity of color in the raw sugar. The advisability of using either of the two processes will therefore be largely determined by the difference in price of dark and light molasses which varies with different localities. In Louisiana it might pay to strive for higher quality molasses by using the carbon on juice or syrup.

SUGAR HOUSE TEST No. 1.

General Analysis.

	Treated	Untreated
Juices:		
Single Polarization	9.57	9.48
Brix	14.4	14.5
Reducing Sugars	0.97	0.95
Apparent Purity	66.5	65.4
Glucose Ratio	10.1	10.0
Syrups:		
Double Polarization	46.5	47.2
Total Solids by Refractometer	60.8	62.8
Reducing Sugars	5.88	6.06
Purity	76.5	75.2
Glucose Ratio	12.6	12.8
Molasses:		
Double Polarization	55.2	55.8
Total Solids by Drying	80.4	81.2
Reducing Sugars	15.38	15.53
Purity	68.7	68.7
Glucose Ratio	27.9	27.8

Non-Sugars.

	Treated	Untreated	Ratio, in %, Treated to Untreated
Juices:			
Free Acids, as aconitic	0.375	0.378	99.1
Total Nitrogen	0.206	0.214	96.3
Ash	3.63	3.55	102.3
Gums	1.174	1.379	85.1
Syrups:			
Free Acids, as aconitic	0.330	0.328	100.6
Total Nitrogen	0.204	0.234	87.0
Ash	3.60	3.58	100.6
Gums	0.500	0.624	80.1
Molasses:			
Total Nitrogen	1.811	2.039	88.8
Ash	35.57	39.26	90.6
Gums	3.701	5.487	67.4

SUGAR HOUSE TEST No. 2.

General Analysis.

	Treated	Untreated
Juices:		
Single Polarization	10.55	10.51
Brix	16.1	16.2
Reducing Sugars	1.03	1.03
Apparent Purity	65.5	64.9
Glucose Ratio	9.8	9.8
Syrups:		
Double Polarization	34.7	40.6
Total Solids by Refractometer	44.6	53.0
Reducing Sugars	3.70	4.54
Purity	77.8	76.6
Glucose Ratio	10.7	11.2
Molasses:		
Double Polarization	51.2	49.1
Total Solids by Drying	77.0	81.8
Reducing Sugars	14.79	18.8
Purity	66.5	60.0
Glucose Ratio	28.9	38.3

Non-Sugars.

	Treated	Untreated	Ratio, in %, Treated to Untreated
Juices:			
Free Acids, as aconitic	0.413	0.404	102.2
Total Nitrogen	0.250	0.270	92.6
Ash	3.95	4.09	96.6
Gums	1.586	1.492	106.3
Syrups:			
Free Acids, as aconitic	0.385	0.403	95.5
Total Nitrogen	0.283	0.311	90.9
Ash	4.02	3.82	105.3
Gums	0.497	0.473	105.2
Molasses:			
Total Nitrogen	2.203	2.389	92.2
Ash	33.76	37.73	89.5
Gums	3.791	4.802	78.9

SUGAR HOUSE TEST No. 3.

General Analysis.

	Treated	Untreated
Juices:		
Single Polarization	9.82	8.99
Brix	14.5	13.4
Reducing Sugars	0.95	0.76
Apparent Purity	67.7	67.1
Glucose Ratio	9.7	8.4
Syrups:		
Double Polarization	29.8	31.7
Total Solids by Refractometer	39.4	43.0
Reducing Sugars	3.12	3.12
Purity	75.6	73.7
Glucose Ratio	10.5	9.8
Molasses:		
Double Polarization	51.2	48.5
Total Solids by Drying	77.6	78.1
Reducing Sugars	15.92	18.25
Purity	66.0	62.1
Glucose Ratio	31.1	37.6

Non-Sugars.

	Treated	Untreated	Ratio, in %, Treated to Untreated
Juices:			
Free Acids, as aconitic	0.634	0.658	96.4
Total Nitrogen	0.216	0.234	92.4
Ash	3.54	4.10	86.4
Gums	0.557	0.716	77.9
Syrups:			
Free Acids, as aconitic	0.533	0.531	100.5
Total Nitrogen	0.224	0.225	99.5
Ash	3.78	4.14	91.4
Gums	0.507	0.517	98.0
Molasses:			
Total Nitrogen	2.032	2.119	95.9
Ash	35.22	38.01	92.6
Gums	4.265	3.915	109.0

SUGAR HOUSE TEST No. 4.

General Analysis.

	Treated	Untreated
Juices:		
Single Polarization	9.00	9.10
Brix	14.00	14.3
Reducing Sugars	0.95	0.95
Apparent Purity	64.3	63.6
Glucose Ratio	10.6	10.4
Syrups:		
Double Polarization	49.9	45.4
Total Solids by Refractometer	67.8	61.9
Reducing Sugars	7.04	5.71
Purity	73.6	73.3
Glucose Ratio	14.1	12.5
Molasses:		
Double Polarization	54.8	54.2
Total Solids by Drying	86.1	80.9
Reducing Sugars	18.38	16.45
Purity	63.6	67.0
Glucose Ratio	33.5	30.4

Non-Sugars.

	Treated	Untreated	Ratio, in %, Treated to Untreated
Juices:			
Free Acids, as aconitic	0.645	0.192	336.1
Total Nitrogen	0.282	0.287	98.4
Ash	3.49	3.66	95.4
Gums	0.642	1.063	60.4
Syrups:			
Free Acids, as aconitic	0.539	0.310	173.9
Total Nitrogen	0.294	0.321	91.7
Ash	4.10	3.98	103.1
Gums	0.358	0.809	44.2
Molasses:			
Total Nitrogen	2.482	2.773	89.5
Ash	37.6	36.31	104.3
Gums	5.105	6.440	79.3

SUGAR HOUSE TEST No. 5.

General Analysis.

	Treated	Untreated
Syrups:		
Double Polarization	36.3	42.1
Total Solids by Refractometer	47.0	55.7
Reducing Sugars	4.38	5.26
Purity	77.2	75.6
Glucose Ratio	12.1	12.5
Molasses:		
Double Polarization	50.4	49.8
Total Solids by Drying	82.5	84.0
Reducing Sugars	22.22	21.19
Purity	61.1	59.3
Glucose Ratio	44.1	42.5

Non-Sugars.

	Treated	Untreated	Ratio, in %, Treated to Untreated
Syrups:			
Free Acids, as aconitic	0.249	0.231	106.9
Total Nitrogen	0.208	0.243	85.8
Ash	3.42	3.73	91.8
Gums	0.293	0.277	105.9
Molasses:			
Total Nitrogen	2.373	2.079	114.1
Ash	46.03	39.48	117.6
Gums	2.772	4.029	68.8

RECAPITULATION OF RATIOS OF VARIOUS NON-SUGARS, BETWEEN TREATED AND UNTREATED PRODUCTS.

	Test 1	Test 2	Test 3	Test 4	Test 5	Average
Juices:						
Free Acids.....	99.1	102.2	96.4	336.1	.....	99.2 (1 to 3)
Total Nitrogen.....	96.3	92.6	92.4	98.4	.....	94.9
Ash.	102.3	96.6	86.4	95.4	.....	95.2
Gums.	85.1	106.3	77.9	60.4	.....	82.4
Syrups:						
Free Acids.....	100.6	95.5	100.5	173.9	106.9	98.9 (1 to 3)
Total Nitrogen.....	87.0	90.9	99.5	91.7	85.8	91.0
Ash.	100.6	105.3	91.4	103.1	91.8	98.4
Gums.	80.1	105.2	98.0	44.2	105.9	86.7
Molasses:						
Total Nitrogen.....	88.8	92.2	95.9	89.5	114.1	96.1
Ash.	90.6	89.5	92.6	104.3	117.6	98.9
Gums.	67.4	78.9	109.0	79.3	68.8	80.7

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